Flipped classrooms for programming teaching

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Abstract

Many researchers acknowledge that programming students who graduate from computer science and information technology are not really prepared for the job market. Accordingly, researchers as well as educators, are continuously looking for new methods, models, and techniques to improve programming teaching and learning. Among the models that have been successfully applied in education, in general, is the flipped classroom. Flipped classrooms are those that make use of online tutorial videos that explain the next lesson in which the students watch them before coming to the physical class. Although the flipped classroom model has been applied widely in education, it has not been used much in programming education. This paper presents a case study on the effectiveness of applying the flipped classroom model in programming classes. Specifically, the study compares the flipped classroom model with the traditional lecture-based model for programming teaching. The case study was conducted on two groups of students for a complete semester in which the first group was taught programming using the flipped model, and the second was taught using the traditional lecture-based model. The results indicated that the flipped classrooms helped programming students to better understand the lessons and motivated them towards learning as compared to the lecturer-based classrooms. The study suggests the integration of flipped classrooms in programming classes.

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1 introduction

Lecture-based classroom model is the most common and traditional teaching method that is used in universities, in which an instructor meets with students face-to-face in a physical class and explain a lecture verbally using aid tools such as a projector, a writing surface, and other tools during a limited class time [1]. Although this model is popular around the world, it has many problems that affect information delivery to the students [2]. With the different levels of students and the limited time of class, the instructor cannot ensure that all the students are engaged and whether they understand the material correctly. Usually, there is no time for asking or answering all students' questions. This causes students to be stressed and confused as they may not be able to understand well and follow the explanation with the instructor [3]. Also, with the lecture-based classroom model, students mostly rely on their instructor as the main resource of information. This may lead to a lack of self-learning skills for many students [4].

The evolution of web 2.0 technology and the ability to share videos through different websites such as YouTube, made it easier for individuals to create and upload content to the internet. Consequently, educators have used these technologies to improve education, and tech-based model started to be used in classes. One such model is the flipped classroom model. Since the process in a flipped classroom is the opposite of a traditional base classroom, the students study the materials at

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home then do the homework or the exercise in class. The flipped classroom model is blended learning, which combines traditional lecture-based face-to-face lectures as well as the use of technology such as educational videos [5]. In a flipped classroom, the use of technology is central, where the instructor provides instructional content such as educational videos and other learning resources for students to view before meeting in class. Class time is then used to interact with students by making them participate and solve problems by applying what they have learned before coming to the physical class. After the class, instructors evaluate their knowledge and what they have learned [6]. Flipped classrooms are student-centered, with the teacher playing the role of facilitator and facilitator [7]. The flipped classroom model is not a new method of teaching but has become popular with the new innovation of technologies [8]. Nemours studies acknowledged that flipped classrooms have many advantages over the traditional lecture-based classrooms. For example, the study of Sahin et al., indicated that students tend to choose classes with videos over classes that do not contain video only rely on reading material. Also, pointed out that the available videos on the internet for the flipped class make students feel flexible about their schedule and relieve them from time pressure and the fear of the instructor monitoring. Moreover, in this study emphasized that when students prepare for the class by watching the videos, this makes them feel more comfortable, effective, entertaining than using notes, books, and any reading materials. For that, using educational videos for flipped classroom model preparation encourage students to prepare for the class with less anxiety [3].

It should be noted that the flipped classroom approach is different from distance learning. In distance learning, students attend the lecture live through videoconference technology and do not come to a physical class at all. In addition, all submissions are made through a learning management system, which also contains tutorials, videos, board discussion, lecture notes, etc. Usually, students who choose distance learning are actually cannot commit to attending the class on time for any reason [9]. After the COVID-19 pandemic, the use of flipped classrooms in universities will increase, and there will be greater reliance on the use of technology in education [10].

This study presents the results of a case study to explore the effectiveness and acceptance of using the flipped classroom model in teaching programming for degree students. The study was conducted in the College of Computer Science, Qassim University, in which this method is applied for the first time.

This paper is structured as follows: Section II presents the related work, Section III reports the methods of the case study, Sections IV and V outline the results and discussion, respectively, and finally, Section VI concludes the paper.

2 Related work

There is an interest from educators to get the most benefit from the education process by applying the flipped classroom model. This section presents an overview of the studies that focus on applying flipped classrooms as a method for teaching either university courses or secondary school subjects. In addition, there are few studies that have been conducted on applying the flipped classroom in teaching programming.

Wang et al. found that using the flipped classroom model in a programming class allows students to use class time to solve real-world problems, whereas the traditional method of teaching programming, in which the instructor is at the center of the class, does not allow students to practice what they've learned with immediate feedback from their instructor. Students are more motivated and engaged with course materials when they use class time for activities, as in the flipped model [4]. According to Puarungroj and Wichai's research, using a flipped classroom for a computer

programming course at Loei Rajabhat University increases interaction between the instructor and students because the instructor uses class time to follow up with each student individually, providing instant feedback and answering questions. In addition, the survey's findings suggest that student involvement with out-of-class materials and in-class activities is very high. Furthermore, pupils were pleased with the teaching method used in this lesson. The performance of students in classes that use the flipped classroom method was good as a result of this study, but it was influenced by students who came to class without preparation [2]. Kneevi et al. used a flipped classroom style of teaching networks in their research since it is crucial to get practical knowledge when studying network courses. The traditional lecture-based strategy, on the other hand, is ineffective for this objective. Many students find the traditional lecture-based paradigm dull because of the variety of information sources available on the internet and the ease with which they may acquire it. In contrast to brief online lesson videos, a long period in a face-to-face class causes students to lose interest and become bored. Junior students, on the other hand, take flipped classrooms more seriously and accept them more readily than freshmen students [11].

In addition, Sahin et al. found that students in a lecture-based paradigm may experience anxiety as a result of failing to take notes or may get unhappy and confused as a result of their inability to follow along with the teacher. Students in the flipped model, on the other hand, do not experience this because they have the ability to re-watch the educational films at any time and from any location. The pattern of preparation that students used to undertake before class has changed with the flipped paradigm. This improves students' comprehension and conviction in their potential to achieve, which is crucial when it comes to overcoming obstacles, achieving goals, and completing activities [3]. The flipped classroom paradigm should be used more in engineering education, according to Liet al. Where the emphasis moved from passively absorbing material delivered in lectures to active learning. The intellectual quality of the students' flipped model activities rises in tandem with their desire to study. Additionally, students find the flipped paradigm to be more enjoyable and engaging. In a flipped classroom, class time is spent on student involvement and classroom activity. Rather of explaining the material, the instructor spends more time connecting with the pupils. As a result, the flipped classroom allows students to put what they've learned into practice under the supervision of the instructor, which strengthens their learning and allows them to improve their skills [5].

The flipped classroom model, according to Anget et al., enhances students' level, as indicated by their final grades. It also encourages kids to continue learning. It is worth emphasizing, however, that the flipped classroom design must be adapted to account for student workload [1]. Wang et al. used a flipped classroom paradigm for teaching PHP in their research, in which students use class time for practice and interaction with other students and instructors. The flipped classroom concept reverses the usual format by moving the lecture out of the classroom and allowing students to work on activities and homework during class time. They discovered that students' achievements and learning abilities have improved [12]. According to Koo et al., students' participation in class activities is preferable than simply sitting and listening. This will encourage students to interact more with the learning materials and their classmates. Previous studies [8] have demonstrated that flipped classes boost students' self-instructed capacity and motivation to learn.

Katsuyuk et al. employed the flipped classroom concept to separate the students into groups based on how much time they spent outside of class understanding and learning. A survey was done at the conclusion of the course. After evaluating the poll findings, it was shown that students with learning disabilities dislike the group flipped classroom. Students with a great ability to learn, on the other hand, like grouping in a flipped classroom. As a result, the comparing must be done

between groups that are on a similar level [6].

Whillier and Lystad discovered that evaluating a subject before deciding to teach it in a flipped classroom is critical because research shows that abstract theoretical materials with a significant amount of information to memorize do not have positive effects on students' achievements and attitudes [13]. Computer courses, according to Li et al., do not rely on theoretical instruction, but rather on practice and application of what is learnt [5].

3 Method and materials

A case study was conducted on the second-year information technology students in the first semester of the 2019 academic year. The case study was carried out within a course entitled "Object-Oriented Programming (OOP)," which is taught with C++ language. This course is given as two hours class per week, and the total number of weeks in a semester is 15 weeks. The course covers many programming concepts, which are decision control, looping statements, functions, arrays, pointers, classes and objects, constructors and destructors, constant object and constant data and member functions, overloading functions, static data member and static member functions, composition, friend functions, inheritance and polymorphism, and file handling.

The following two sub-sections present the details of the case study design as well as the material used.

3.1 Design

This case study uses convenience sampling, where students registered in the course are the selected sample. Upon registration, students were automatically assigned by the college system into two sections of 5 and 37 students, respectively. To form the case study groups, the five students were assigned to the first group, which is the experimental group, i.e., flipped classroom group. For the second group, 5 of the 37 students have been chosen. To choose them, both groups were given a simple programming pre-test, and five students who have a similar grade with the experimental group students were assigned to the control group, which is actually a lecture-based group. The pre-test was given to make sure the two groups are comparable in terms of programming level. The pre-test consists of three questions pertaining to a written code, the first and second questions asking about the output of this code with different input. The third question asked to write what is the general idea of this program. Both groups were taught by the same instructor.

Figure 1 shows the case study design. The study was conducted for a complete semester. Both groups have been given the pre-test at the beginning of the semester to determine pre-existing knowledge and choose the five students for the control group and a post-test at the end of the semester. They were also given a feedback survey by the end of the semester. The details of the pre/post-tests and the feedback survey are given in the next section.

For the lecture-based classroom group, i.e., the control group, the instructor explains the lessons to the students in the classroom during the lecture time. Usually, in the lecture-based class, it is theoretical-based, where a projector is used to show the lesson's PowerPoint slides. The lesson often contains program syntax and semantics, followed by an example to explain how and when to use the statements and how to build a program. Besides, the instructor clarifies common mistakes to avoid. Furthermore, the instructor tries to answer students' questions if the time allows, and also ask students questions to make sure that there is no confusion of the concepts given in the lesson. The lecture is then followed by a lab, usually in another day, in which students practice what they have learned in the lecture and solve some programming problems and take feedback from the instructor.

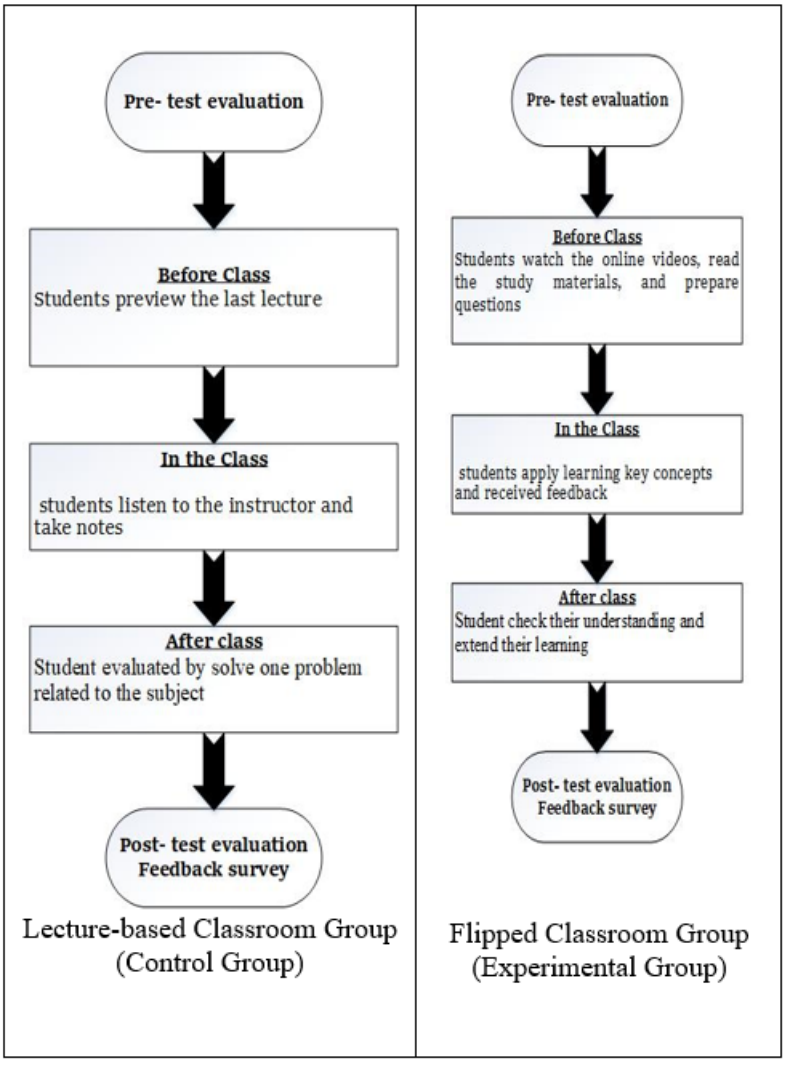

FIGURE 1. Study Design

For the flipped classroom group, the corresponding videos of the next class are pre-recorded and uploaded to a YouTube channel that was created for the course. The instructor has made this channel and regularly upload the video, week by week, to cover all the topics of the syllabus. The videos are usually available for students seven days in advance before coming to the class. Students are required to watch the video, read the related material, and prepare questions if they have any before class time. During class time, students can ask questions about the subject and practice the knowledge they learned from the videos and have support from the instructor and other students. To encourage students to prepare for the class, they were promised to be given extra marks if they collect the target number of points for answering questions about the topic at the beginning of the class. In addition to that, students practice in a lab session and solve some programming problems and take feedback from the instructor the next day what they have learned. To make it clear to the students, At the beginning of the semester, the instructor explains to the students the rules and responsibilities of the flipped classroom and what are expected from the students to do before class, during class, and after class.

For both groups, Blackboard is used to upload course materials and also links to the corresponding YouTube videos for the flipped classroom group.

3.2 Materials

The materials include the pre-test/ post-test, the tutorial videos, and the feedback survey. The pre-test/post-test contains three questions about a segment of code (see Figure 2). The first and second questions are to find the outputs of the code for two different inputs, while the third question is the write the main purpose of the code. The code segment is to write the timetable of a given input.

The first question is the easiest in which the students need to find the output for input 2, which is a positive integer number and fit nicely with the statement "Enter a positive integer:". The second question is a bit harder, in which the students trace the code for negative input. Although a statement in the code asks the user to enter a positive integer, there is not any verification for the entered number to be a positive number. The third question is the most abstract question in which the students must understand the whole segment and summarize it one or a few sentences in their language.

The tutorial videos of the YouTube channel cover the topics of the syllabus. In all videos, code::Blocks software is used as an integrated development environment (IDE) to write and compile the code, Microsite whiteboard to write problems and syntax, and to explain how the structure of the program works to get the output from the program. Camtasia Recorder 2018 is used to record the screen, TechSmith Camtasia to edit the video, and Newer NW-700 Professional condenser Microphone to record the voice. The video starts with a simple explanation of how and when to use this the concept of programming and then explain the code line by line. Each video covers only one concept with duration no longer than 15 minutes. Some topics are divided into more than one video. At the end of the semester, the YouTube channel had more than 100 tutorial videos. The duration of the videos ranges from 6 to 15 minutes. Figure 3 shows a screenshot from the channel, and you can find the channel online at this link https://www.youtube.com/channel/UC3zD-hN3fJzLmkMULaSy82Q

At the end of the semester, a feedback survey was given to the students of the flipped classroom, containing questions about the difficulties and challenges they might face. It also gets to know whether they were motivated and interested in the course. Figures 4 and 5 shows sample questions of the survey. The complete survey questions are available in the appendix of this study.

Read the code below:

main.cpp

```
1  #include <iostream>
2  using namespace std;
3
4  int main()
5  {
6      int n;
7      cout << "Enter a positive integer: ";
8      cin >> n;
9      for (int i = 1; i <= 10; ++i) {
10         cout << n << " * " << i << " = " << n * i << endl;
11     }
12
13     return 0;
14 }
```

Q1: What is the output if n=2?
Q2: What is the output if n=-5?
Q3: What is the purpose of method main ( ) ?

FIGURE 2. Pre-Test/post-Test Questions

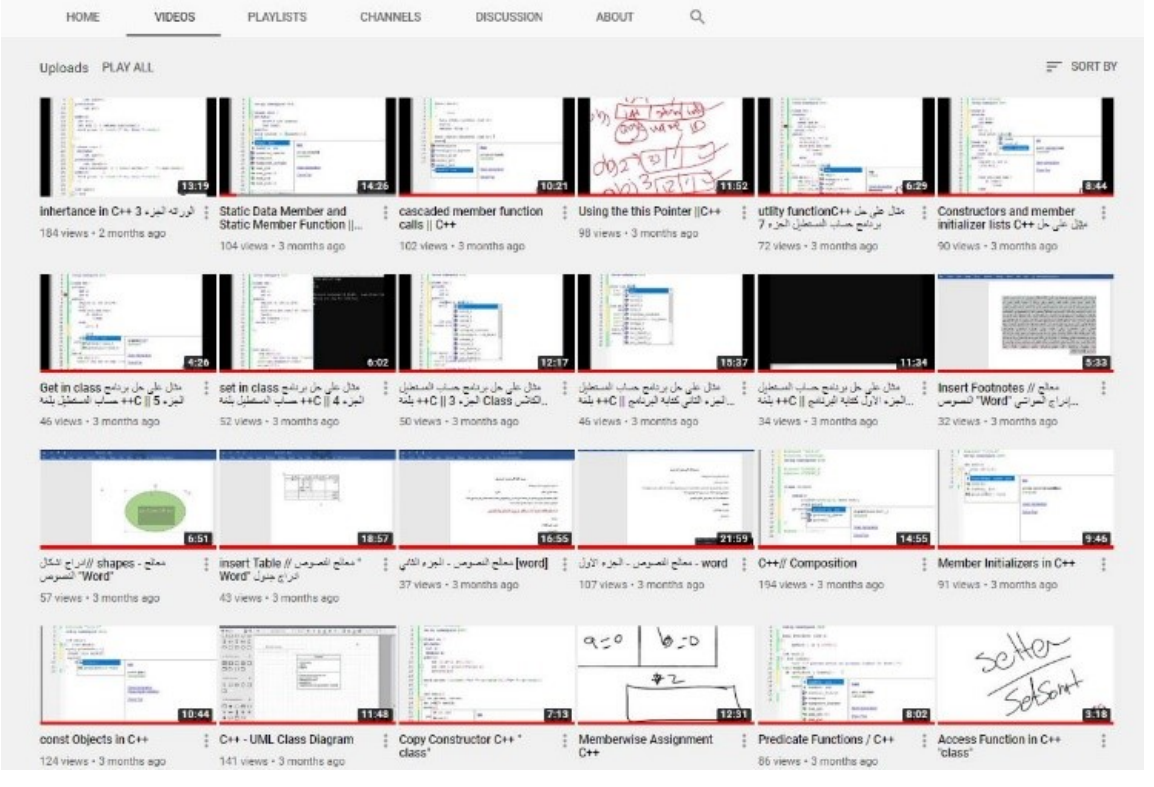

FIGURE 3. Screenshot from YouTube

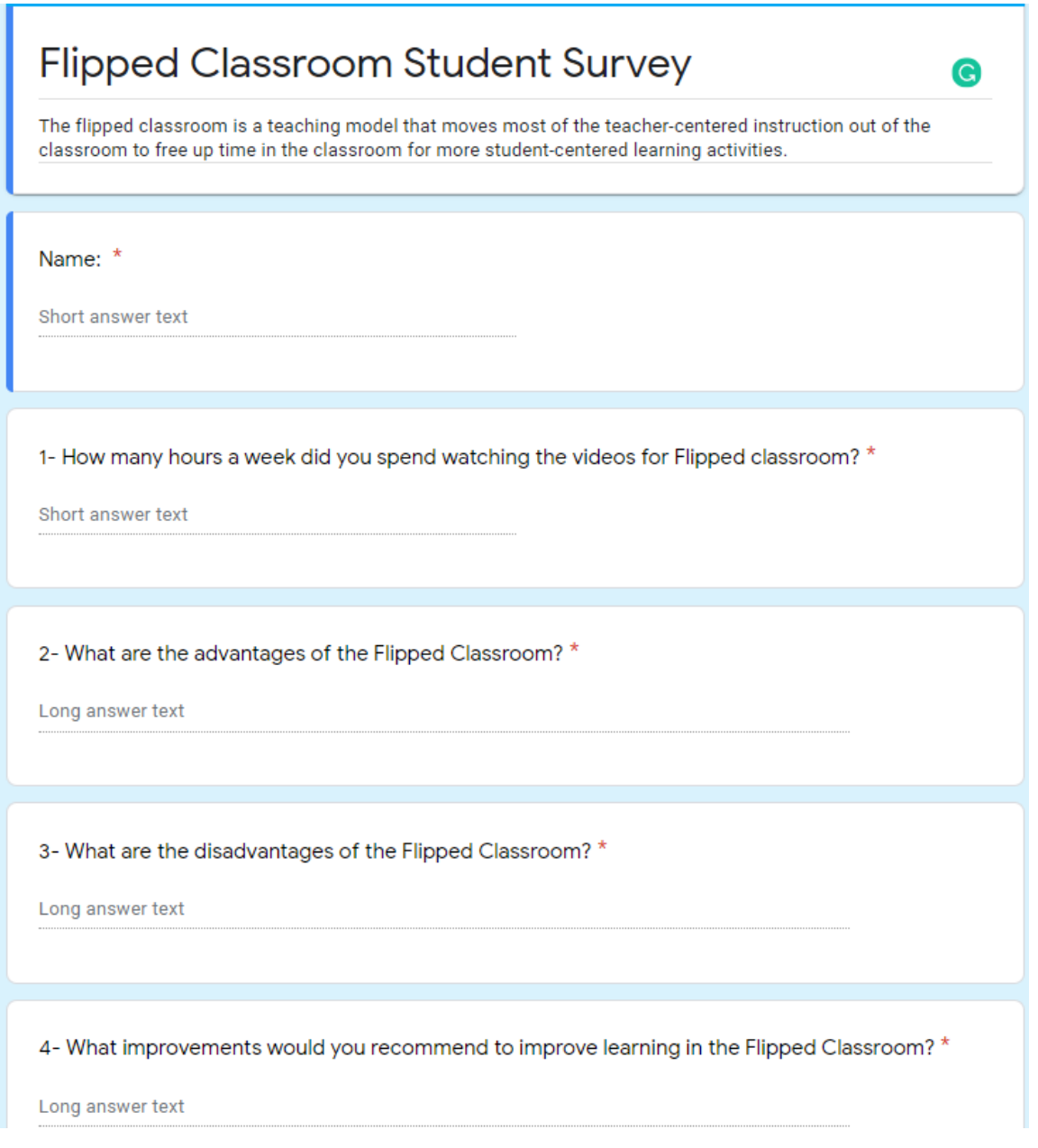

FIGURE 4. Screenshot#1 from the survey

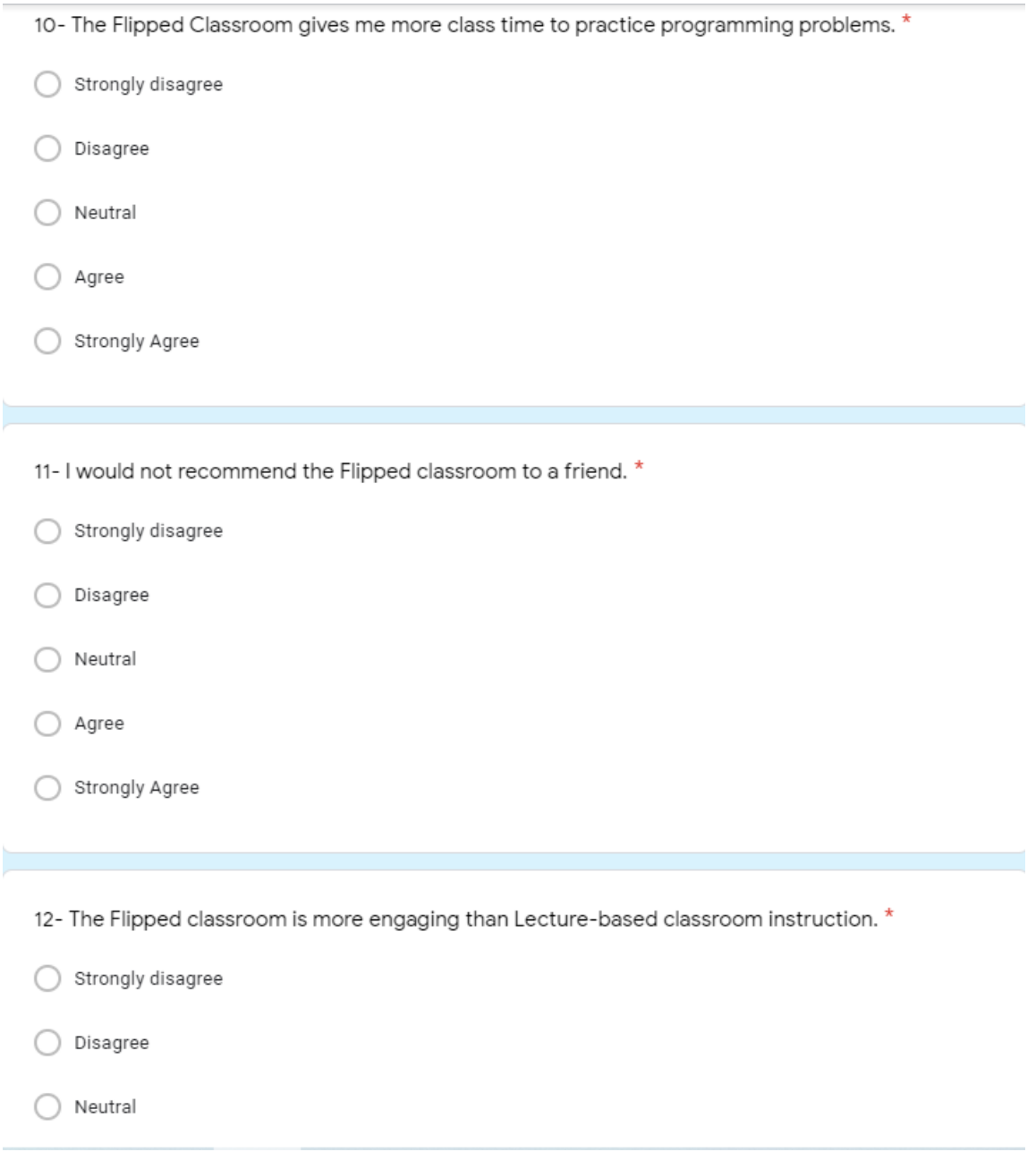

FIGURE 5. Screenshot#2 from the survey

4 Result

Each of the two groups had a pre-test at the beginning of the semester and an equal post-test at the end of the semester. The flipped class, as well as the lecture-based class, contained five students. Although the number of students in the lecture-based group was 37 students at the beginning, we have selected 5 of them for the case study. The selection was based on the pre-test results. Table 1 shows the number of students who answered the question of the pre-test for both groups.

Table 1. Number of students answered the question in both groups.

2*#	**Number of students answered the question**	
	Flipped	**Lecture-based**
Q1	2	1
Q2	1	1
Q3	0	1

As shown in Table 1, there are three students from the two groups who answered the first question correctly by writing the multiplication tables of 2. Two students answered the second question correctly by writing a multiplication table of -5. However, those students were deceived by the sentence written in the print statement asking the user to enter a positive integer number so they consider the entered number is wrong. This is because students did not pay attention to the statements that exist in the code, which did not prevent the entry of a negative number. Therefore, they wrote that the entry was wrong or wrote the multiplication table for a positive 5. The question that students answered poorly is the third question. Only one student wrote a completely correct answer. Some of the students preferred not to answer the question and leave it blank. Others answered by writing about the rule of the main function in the C++ language. Finally, there were some students who provided incomplete answers by not mentioning the role and importance of for loop to extract the multiplication table. Table 2 shows the pre-test/post-test results for each student in the two groups. We refer to the students of the flipped group as (F1, F2, F3, F4, and F5), while we refer to the lecture-based group students as L1, L2, L3, L4, and L5. Two points were assigned to each question, which then normalized to be out of 100.

Table 2. Number of students answered the question in both groups.

Flipped Group			**Lecture-based Group**		
Student #	**Pre-test**	**Post-test**	**Student #**	**Pre-test**	**Post-test**
F1	67	100	L1	67	34
F2	67	100	L2	67	100
F3	0	67	L3	0	50
F4	17	100	L4	17	17
F5	9	100	L5	9	9

As shown in Table 2, students' scores in each group are equal in the pre-test. This is because students of the lecture-based group were chosen to be equal to the flipped classroom group. According to the table, all students of the flipped group showed an improvement in their grades. On the other hand, only two of the lecture-based students showed an improvement, two remained the same, and one even performed worse. The difference between the post-test and the pre-test indicated that the flipped classroom students performed better as compared to the lecture-based students. To get a better idea of the results, we discuss how the two groups performed in each question.

4.1 Question 1

For the flipped classroom group, the students' answers to this question were as follows. Students F1 and F2 answered questions 1 correctly by writing the multiplication table of 2. Student F3 answered wrongly by writing the number 2 as an output for question 1. Student F4 wrote the sentence from the cout statement, then number 2 without writing the multiplication table of 2, which is an incorrect answer. Student F5 did not write any answer.

On the other hand, in the lecture-based classroom pre-test, student L1 answered questions 1 correctly by writing the multiplication table for 2. Student L2 wrote an incomplete multiplication table, which means the student did not trace the for loop correctly. Student L3 answered question 1 by re-writing the cout statement only. Student L4 did not answer correctly question 1 by writing number 8 only as an output for all statements. Student L5 left it empty.

4.2 Question 2

Student F1 answered correctly questions 2 by writing the multiplication table for -5. Student F2 wrote a multiplication table for positive five not a minus five. Student F3 wrote an error as an answer to question 2. Student F4 wrote an error as an answer for question 2. Student F5 did not write an answer to question 2.

Student L1 answered questions 2 correctly by writing the multiplication table for -5. Student L2 wrote an incomplete multiplication table for questions 2. Student L3 answered question 2 by writing errors. Also, student L4 considered it as an error. Student L5 thought that there is no output for question 2, explaining that by writing n=-5, which is not a positive number.

4.3 Question 3

Student F1 answered incorrectly by understanding the question wrong, answering about the main () function of the whole program in general, not specifically about the purpose of the code in the question. Student F2 answered question 3 by calculating the multiplication table without mentioning about the for loop or repetition. Student F3 did not answer question 3. Student F4 answered the question by writing the output of the for loop without mentioning the aim of using the "for" to calculate the multiplication table. Student F5 answered question 3 by writing the word "for" only.

In the lecture-based classroom pre-test, student L1 did not answer question 3. Student L2 wrote the correct answer by writing the aim of the code. Student L3 did not answer question 3. Student L4 answered question number 3 by writing that it is a repetition statement. Student L5 mentioned 10 times in answer to question 3.

At the end of the semester, the students took the same test they had at the beginning of the semester. Results are shown in Figures 6 and 7 for flipped and lecture-based groups, respectively. The results of the post-test of the flipped classroom group showed an increase in the students' understanding as 4 out 5 of the students answered all the questions correctly and got the full mark. On the contrary, 1 out of 5 of the students from the lecture-based classroom got the full mark, one student improved, one other student's mark decreased, and two students remained at the same level.

Based on the literature search, more than 80 scientific papers have been obtained discussing the use of augmented reality technology in the world. In the next step, all papers not related to SA were excluded. After that, the research was strictly dedicated to obtaining AR applications in SA only. The remaining scientific papers were sorted to obtain the scientific papers that present the AR applications in the field of EC in SA.

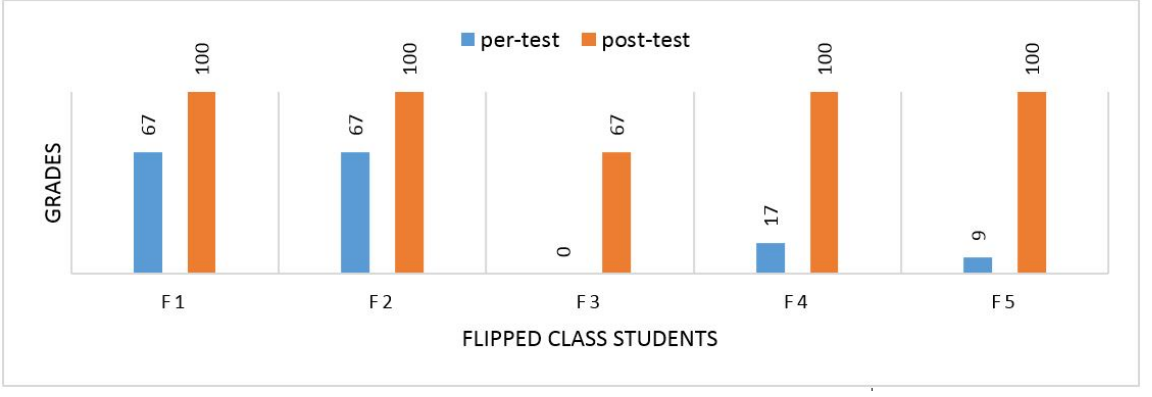

FIGURE 6. Pre- test and Post-test for Flipped classroom model

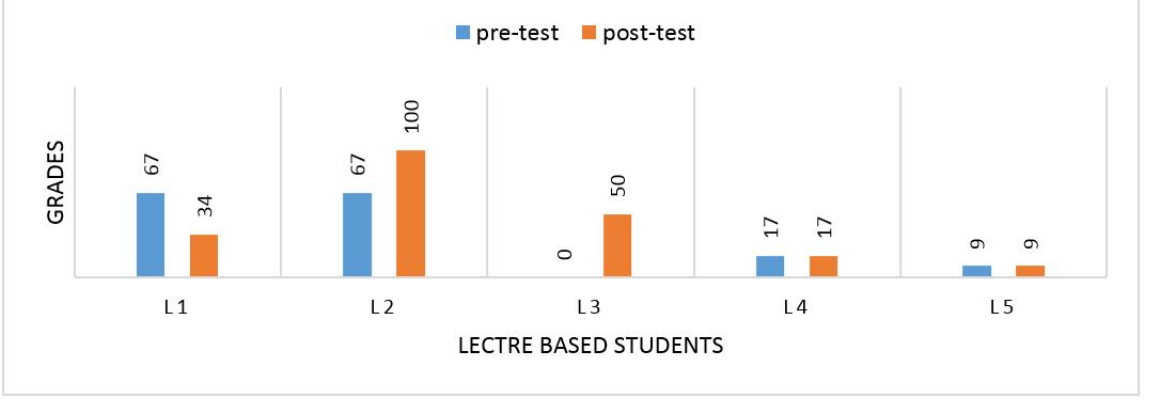

FIGURE 7. Pre-test and Post-test for Lecture Based model

5 Discussion

The results showed that the students learn better with the flipped model as compared to the lecture-based model. Before the class, students of the flipped model learned basic concepts by watching tutorials videos. Therefore, lecture time was devoted to practicing interactive learning and answering students' questions [14]. The success of the flipped classroom depends on an important and influential factor, which is the preparation of students before attending the classroom by reading or watching what is expected of them according to the distribution of the curriculum [15].

The flipped model of teaching is not a popular model of teaching programming in Saudi Arabia. In the feedback survey mentioned earlier, our aim was to understand the point of view of students toward the flipped model and to explore the motivation, application, advantages, and disadvantages of the flipped classrooms.

The feedback survey showed that all the students prepare for the class by watching the videos before coming to the class. The number of hours they spend to prepare for one to six hours per week. All of them watch the tutorials videos at home, mostly on weekends. Students rely mainly on watching educational videos and sometimes refer back to the slides. However, the students do not refer to the books as a reference for them to prepare before attending the lecture. Students agree that making videos available on the YouTube platform makes it easy and convenient because they can watch anywhere and anytime. When students watched the videos, 4 of 5 students indicated that they take notes, stopped when needed, and re-watched sections when they did not understand a concept. All of them marked when they had questions in the notes. Also, 3 of 5 students paid full attention to the video with no distractions. Only one student mention that she directly practices the concept by stopping the video from applying what she learned directly then continue. A disadvantage of the flipped approach from the students' perspective is the difficulties in time management, especially with the pressure of study other subjects.

On the other hand, the advantages of the flipped approach from the students' perspective are the ability to retrieve the information and study it again, no matter when or where. Knowing the subject and prepare the questions before going to the lecture. The ability to re-watch the videos thousands of times to absorb the information when needed. On the contrary, it is possible to speed up the video not to get bored if I know the information. Participation in class time develops more programming skills and makes the information do not forgettable. They find Flipped classroom more fun and a change from the boring traditional way.

Moreover, students agree that flipped classroom improve their performance, achievements, and motivation for learning C++ programming language. All students strongly agree they are more motivated to learn C++ or other programming courses in the Flipped Classroom. Four students will recommend the Flipped classroom to a friend. All students agree the flipped approach has helped learn more than they would have if they had used the lecture-based class. Also, they all find it is helpful to do course exercises when other students and the instructor are available to answer questions as opposed to doing the homework exercises alone. Students in the flipped classroom model found that their performance in this class is better than traditional courses. Likewise, they wish to have more flipped classroom courses, but unfortunately, 4 of 5 does not expect to have future flipped classroom courses.

Besides, students agree that understanding the central concept before coming to the class helps them to get a better understanding of the course and make it easier to learn deeper and understand more in detail. Also, participation in class helps the students to be more confident and less confused

about the contents. Uploading the videos on YouTube give students the freedom to watch the tutorials with any platforms, anytime, anywhere. That allowed the students to re-watch the whole tutorial or specific part until they make sure they fully understand it. The previous videos available for them to watch anytime when they feel the need to go back to study it. This model of teaching is more fun and engaging than the lecture-based classroom because students use lecture time to apply what they learned and interact with the instructor and other students. However, all the students find that it is difficult sometimes to find the time to watch the videos at home and take notes because it requires time management skills. In general, students show a positive attitude toward the flipped classroom. Finally, the students' feedback showed good improvement in students learning, understanding, and knowledge. Also, the survey results showed the students are more motivated and have a positive attitude toward the course.

6 Conclusion

The popularity of the flipped classroom model increased in general and was supported by many educators. This study showed the effectiveness of applying the flipped classroom model in comparison with the traditional lecture-based model of teaching computer programming. In the flipped classroom, students showed progress in the level of understanding of the content of programming concepts with the development of their performance, unlike students in the traditional classroom model. Furthermore, the students in the flipped group showed a positive attitude towards the course and more enthusiasm for learning using this model in the future. Further research is required to evaluate the efficacy of the flipped classroom model of teaching programming.

7 Appendix: The feed back survey questions

1. How many hours a week did you spend watching the videos for the Flipped classroom?
2. What are the advantages of the Flipped Classroom?
3. What are the disadvantages of the Flipped Classroom?
4. What improvements would you recommend to improve learning in the Flipped Classroom?
5. Where did you watch the videos the majority of the time?
6. I watch the flipped classroom YouTube videos on time:
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
7. I feel confident about the material after watching but before coming to the class to solve problems
    - Strongly disagrees
    - Disagree

- Natural
- Agree
- Strongly agrees

8. I am more motivated to learn C++ or other programming courses in the Flipped Classroom.
   - Strongly disagrees
   - Disagree
   - Natural
   - Agree
   - Strongly agrees
9. I regularly use the resources provided online such as slides, PDF.
   - Strongly disagrees
   - Disagree
   - Natural
   - Agree
   - Strongly agrees
10. The Flipped Classroom gives me more class time to practice programming problems.
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
11. I would not recommend the Flipped classroom to a friend.
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
12. The Flipped classroom is more engaging than Lecture-based classroom instruction
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree

- Strongly agrees

13. I like watching flipped classroom lessons on YouTube
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
14. I anticipate that I will experience another Flipped Classroom in the future
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
15. The flipped approach has helped me learn more than I would have if we had used a Lecture-based class
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
16. It is helpful to do course exercises when other students and the professor are available to answer questions as opposed to doing the homework exercises by myself.
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
17. I feel the Flipped Classroom be useful for other subjects
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree

- Strongly agrees

18. Flipped classroom entails a larger workload than a Lecture-based class
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
19. My performance in Flipped classroom class is better than Lecture-based class
    - Strongly disagrees
    - Disagree
    - Natural
    - Agree
    - Strongly agrees
20. When you watched the videos, did you
    - Take Notes
    - Stopped when needed
    - Marked when you had questions in the notes
    - Re-watched sections when you did not understand a concept
    - Paid 100% attention to the video with no distractions

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